

Risk Factors for Hospital Admission After Anterior Cruciate Ligament Reconstruction

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Purpose: To determine patient and surgical risk factors for admission after anterior cruciate ligament reconstruction (ACLR) using the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database. **Methods:** All instances of ACLR from 2005 to 2014 from the ACS NSQIP prospective database were analyzed. Both univariate analysis and binary logistic regression were performed to determine which patient demographics and medical comorbidities were associated with admission after surgery. **Results:** Of the 9,146 patients undergoing ACLR, 1,197 (13.1%) required admission. Univariate analysis found that the following variables were associated with the need for admission: decreased age, Hispanic ethnicity, higher American Society of Anesthesiologists class, higher Charlson Comorbidity Index, use of an epidural anesthesia, longer operative times, prior operation within 30 days, dyspnea, smoking, diabetes, chronic obstructive pulmonary disease, previous cardiac surgery, hypertension, previous revascularization procedure, and a known bleeding disorder. Independent predictors of admission on multivariate analysis included Hispanic ethnicity (odds ratio [OR] 8.9), use of epidural anesthesia (OR 6.3), known bleeding disorder (OR 4.02), increased body mass index (OR 1.03), longer operation time (OR 1.012), and younger age (OR 1.008). **Conclusions:** Our study identifies Hispanic ethnicity, use of epidural anesthesia, and history of bleeding disorder as major independent risk factors for admission after ACLR. **Level of Evidence:** Level III, retrospective comparative study.

Anterior cruciate ligament (ACL) injury is commonly encountered by orthopaedic surgeons, with some annual estimates of this procedure as high as 300,000.¹⁻³ ACL reconstruction (ACLR) is a relatively safe surgical procedure and is generally performed on an outpatient basis in the United States.⁴⁻⁷ Most literature regarding the complications of ACLR addresses long-term complications such as reinjury, graft failure, and the development of degenerative arthritis.⁸⁻¹¹

Recently, less common short-term complications have also been addressed, including symptomatic deep venous thrombosis, return to the operating room, and

infections.¹² Despite this, there is limited information on patient risk factors leading to inpatient admission after ACLR. With a rising trend toward bundled payments, and attempts to minimize or eliminate the need for hospital stay, it is important to be aware of risk factors that predispose patients to adverse outcomes and admission as a direct result of surgery. A study of Medicare patients undergoing any type of outpatient surgery found a rate of admission of 8.41 per 1,000 procedures in ambulatory surgery centers and 21 per 1,000 procedures in a hospital setting.¹³ Although this study did not specifically address risk factors leading to admission, previous studies using large and nationally available databases have assessed risk factors such as ethnicity, age, and body mass index (BMI).¹²

Knowledge of patient risk factors for admission after ACLR is important to allow surgeons to properly counsel their patients regarding their postoperative course. The aim of this study was to determine patient and surgical risk factors for admission after ACLR using the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database. We hypothesized that patients with a higher number of medical comorbidities, higher BMI, and longer surgical times would be more likely to be admitted after ACLR.

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Methods

Data Source

To study admission after ACLR, the ACS NSQIP database was used. This database represents a high-quality, prospectively collected surgical database encompassing approximately 750 medical centers from January 2005 to December 2014, making it well suited for our study. To maintain database quality, hospitals are excluded from ACS NSQIP if their interobserver disagreement rate between clinical reviewers is greater than 5% or if their 30-day follow-up rate is less than 80%. Finally, this database provides a highly accurate source of postoperative admission, patient demographics, and medical comorbidities and has been validated for a large number of orthopaedic procedures to date, including ACLR.^{12,14-23}

Data Collection

All cases from January 2005 to December 2014 with the Current Procedural Terminology code 29,888 ("Arthroscopically Aided Anterior Cruciate Ligament Repair/Augmentation or Reconstruction") were included. To assess potential patient risk factors for admission, a number of variables were collected, including age, sex, race, BMI, smoking status, type of anesthesia used during surgery (epidural, general or monitored anesthesia care, and regional blockade), and American Society of Anesthesiologists class ranging from 1 (healthy patient) to 4 (potentially life-threatening medical disease). For each patient, individual medical comorbidities were collected, and the preoperative Charlson Comorbidity Index was subsequently calculated as a global measure of health status.²⁴

The primary endpoint assessed was the need for inpatient admission after ACLR. Although the need for admission after surgery is documented in the NSQIP database, it does not specify the medical reason for admission. Multiple continuous variables were converted to categorical variables within the univariate analysis for the purposes of data analysis including age (<20, 20-30, 30-40, >50), diabetic status (yes or no), and BMI (<18.5, 18.5-25, 25-30, >30), both to aid in data analysis and to allow for more specific patient education according to which range they fall within. For the purposes of multivariate regression, however, these were treated as continuous variables. The following medical comorbidities were included in the NSQIP database but were not included in the data analysis as these were not present in any of the patients undergoing ACLR: ventilator dependence, current pneumonia, presence of ascites or esophageal varices, vascular claudication at rest, coma, central nervous system tumors, disseminated cancer, chemotherapy, radiotherapy, or need for blood transfusion within 30 days of surgery.

Both univariate and multivariate logistic regression were performed to assess for any patient demographics or comorbidities that represent independent risk factors for inpatient admission after ACLR.

Statistical Analysis

Univariate analysis was performed for each individual patient demographic and medical comorbidity to determine which variables to include in the multivariate analysis. Both 2-sample z-testing and χ^2 with Fischer exact analysis were used as appropriate for univariate analysis. All variables with a *P* value less than .05 were considered significant and ultimately included in a binary logistic regression model for the need for inpatient admission. Binary logistic regression was performed and the resulting odds ratios (ORs) with 95% confidence intervals (CIs) were calculated for all independent predictors of postoperative admission. Results were considered statistically significant with a *P* value lower than the specified cutoff of .05 (SPSS Statistics V21.0, IBM, Armonk, NY).

Results

Univariate Analysis

Of the 9,146 patients undergoing ACLR, a total of 1,197 ultimately (13.1%) required inpatient admission after surgery. A list of each variable tested in the univariate analysis is shown in [Table 1](#).

Patient Demographics

Age (*P* = .038), ethnicity (*P* < .001), BMI (*P* < .001), American Society of Anesthesiologists class (*P* < .001), and Charlson Comorbidity Index (*P* < .001) were all significantly different for the patients requiring admission. More specifically, the admitted group had a larger proportion of patients who were younger than 30 years (50.1% vs 46.0%), of Hispanic ethnicity (3.8% vs 0.4%), had BMI >30 (34.8% vs 25.2%), were American Society of Anesthesiologists class 3 (6.9% vs 3.7%), and had Charlson Comorbidity Index >0 (3.9% vs 1.7%).

Operative Variables

With regard to operative variables, admitted patients had longer operative times (131.7 vs 97.5 minutes, *P* < .001), received more epidurals (9.8% vs 2.5%, *P* < .001), and were more likely to have had an operation in the prior 30 days (0.5% vs 0.1%, *P* = .03).

Medical Comorbidities

Finally, multiple medical comorbidities were more common among the admitted group ([Table 1](#)), including diabetes (*P* < .001), smoking (*P* = .01), history of dyspnea (*P* < .001), chronic obstructive

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